CARBOHYDE

SUGAR IS LIFE

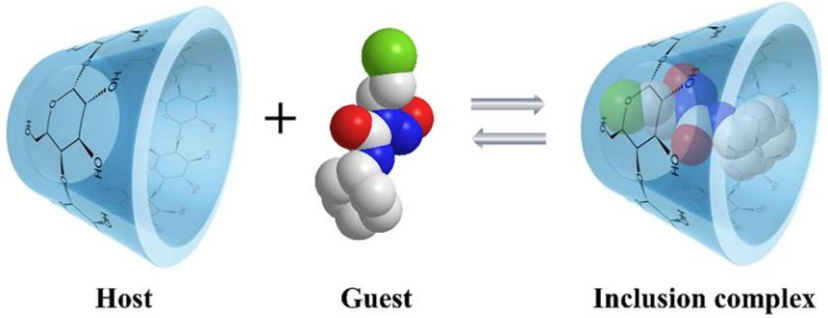
Cyclodextrins

Application in Agriculture

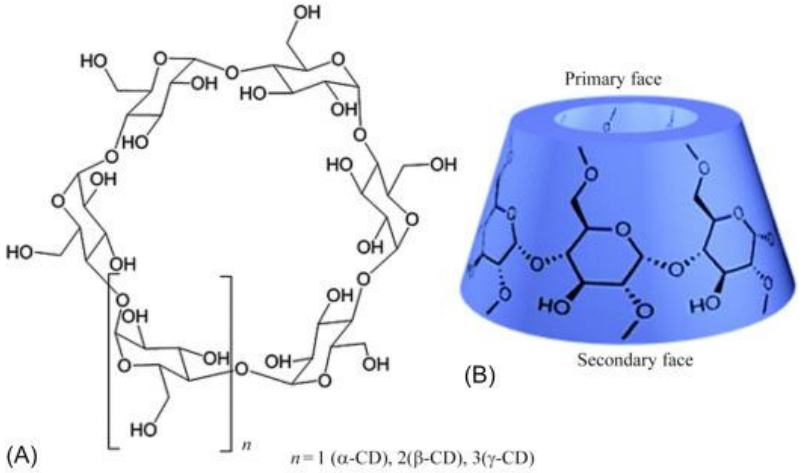
What are Cyclodextrins (CDs)?

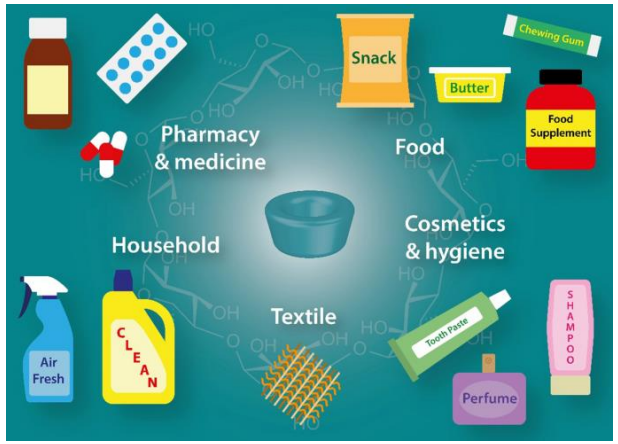
Properties

- Naturally occurring cyclic molecules composed of sugars
- Safe to use
- Used in food, cosmetics & hygiene, pharmaceuticals, agriculture, etc.
- Sub-nanometer sized molecular containers with hydrophilic outer phase and hydrophobic interior properties
- Reversible inclusion complex formation



Structure and application of CDs





Why use CDs in Agriculture

- improvement of the physico-chemical characteristics of pesticides (lipophilicity, phase-transition, wettability, vapour pressure, solubility, reduced volatility, etc.)
- improvement of shelf life (stabilization against light and biochemical degradation)
- minimizing the container/content interaction in packaged formulations
- prolonged or controlled release of active
- ensure homogeneity and content uniformity (molecular dispersity)
- enhancement of bioavailability and absorption
- reduction of the applied dose and thus the environmental pollution
- IP advantages (life-cycle management)

Why use CDs in Agriculture

Pesticide	Type of CD	equilibrium water content in solid form (%) by weight	pesticide content in the formulation (g/100g)
Sumithrin	βCD	6	11.6
MGR-264	βCD	6.6	12.2
Malathion	αCD	7	10.8
Malathion	βCD	7.5	19
DDVP	βCD	5.9	16
DDVP	αCD	5	18.5
Dursban	βCD	8.2	14.2
Sulprofos	βCD	5	12.8
Sulprofos	αCD	4.3	13.7
Fenitrothion	βCD	5.8	14
DEET	βCD	6	10.7
DEET	αCD	4.6	12.2

Pesticide load and water content of cyclodextrin complexed liquid pesticides converted into microcrystalline solids

10-20% active ingredient load with superior bioavailability can be achieved

Why use CDs in Agriculture

CD treatment of plant seeds

- Delayed germination due to complexation of growth hormones
- Enhanced growth and yield

Cyclodextrins and their industrial uses pp 175-210 Edited by:D. Duchene , Editions de Santé, 1987 Szejtli, J.; Tetenyi, M.; Rajki, E. Acta Agron. Acad. Sci. Hung., 32, 74-8 (1983)

Why use CDs in Agriculture

Protection and extension of bee lifespan by CDs

Methyl-βCD and hydroxypropyl-βCD may provide good binding to organophosphates, pyrethroids and neonicotinoid pesticides. The treatment of healthy adult worker honey bees with CD acts to extend the lifespan of the bees and is absent of any measured negative effects.

A formulation containing CDs and one or more vitamins (vitamin A, D, E, etc.), minerals, nutrients, fat-soluble components increases the overall wellbeing of the bees.

PCT patent application W02021011568 - Compositions and methods for improved honey bee health

Why use CDs in Agriculture

Cyclodextrin/carotenoid complex in fish feed

Suitable carotenoids in cyclodextrin complex are added to the feed given to farmed fish in order to achieve red/orange-colored flesh.

A complex between a carotenoid, e.g., astaxanthin, and cyclodextrin improves both the pigmentation in tissues of animals (especially fish with colored flesh: salmon and trout) and the storage ability of the complex in relation to un-complexed carotenoid.

PCT patent application WO2004005353 - Complexes of cyclodextrins and carotenoids

Possibilities for CD use in animal husbandry

Vitamins and CDs

- β-CDs improve pharmacokinetics of α-tocopherol in heifers
- CD encapsulated vitamin K (K1, K2) can reduce osteochondral effects in animals

Essential oils and CDs

Several patents are about essential oil formulations with cyclodextrins, e.g.:

- Camphor oil (-respiratory stimulant)
- Lemon oil (-flavor enhancer)
- Cinnamon oil (-flavor enhancer)
- Garlic oil (-antimicrobial)

CDs in feeds

CDs were shown to have certain advantageous effects on feeds like inhibition of certain mycotoxins, and taste/odor masking for additives

Effects of cyclodextrin complexes on methane production in heifers

The β-CD complex with guest materials appears to be a promising solution to mitigate methane emissions without reducing energy intake

Artificial fertilization

- Improvement of semen quality by cholesterol supplementation (cryopreservation)
- Enhancement of capacitation and fertility rate by pre-incubation of thawed sperms

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